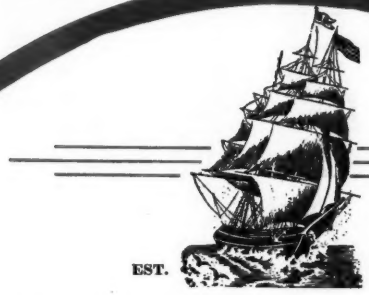
The American Fertilizer

SEPTEMBER 28, 1940

No. 7



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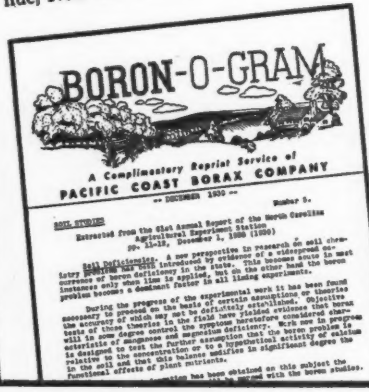
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Vol. 93 SEPTEMBER 28, 1940 No. 7

Economic Feasibility of Expanding the Western Phosphate Industry

By CHARLES J. BRAND

Executive Secretary and Treasurer, The National Fertilizer Association, Washington, D. C.

An Address Before the Fourth Regional Phosphate Conference, Ogden, Utah, September 5-6, 1940

THIS year marks the 100th anniversary of Justus von Liebig's famous address before the British Association for the Advancement of Science. It was in that address that the first publicity was given to the idea of acidulating phosphates to make their plant food content more available, although the idea of treating bones with a mineral acid had been suggested by Escher five years before. Liebig in his remarks suggested the use of sulphuric acid as the acidulating agent, and so was superphosphate conceived. The superphosphate industry was born two years later when Lawes took out his patent for the manufacture of superphosphate by treating mineral phosphates with sulphuric acid. At the 100th meeting of the American Chemical Society next week in Detroit, the Fertilizer Division will hold a symposium commemorating Liebig's contributions to fertilizer chemistry.

The process suggested by Liebig and put into operation by Lawes is still in use and produces the major portion of the world's available phosphoric acid for agricultural needs. World consumption in 1937 was about 17,000,000 metric tons, equal to about 19,000,000 short tons.

In considering the topic of my discussion today, it appears that only the economic phases are really important. I shall be very frank and present the picture as I see it.

There is no need for extensive experimentation on methods for the production of available phosphoric acid from western rock, as distinguished from rock from other sources. Chemists, chemical engineers, and metallurgists have convinced themselves, and should have convinced us, that the processes that are successful on Florida or Tennessee, North African or Christmas Island phosphate rock will be successful (at least, with only minor modifications) on the phosphates of Idaho, Montana, Utah, and Wyoming. In fact, nearly all the processes in use today for the production of available phosphoric acid have been proven on western rock also.

Before taking up the details of my subject, I want to give you a quick statistical picture of the fertilizer consumption situation with which we must deal in any intelligent planning for the use of the western phosphate deposits.

In 1939 total fertilizer consumption in the United States was 7,589,349 tons. Consumption in the 11 States comprising the Western Grand Division was 286,244 tons. The three Pacific Coast States—California, Oregon, and Washington, consumed 256,023 of these tons. This leaves only about 30,000 tons used in the other eight States, namely, Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Nevada, and Utah.

The long-range development of fertilizer use in the Western States and in the United States is shown in Table I.

We cannot avoid the fact that for the present we are confronted with a consumption area that uses only about 30,000 tons of commercial plant food.

The economic phases of the western phosphate problem present themselves along two fronts: (1) Can the areas adjacent to our western rock deposits consume more available phosphates? and (2) can the area of consumption be extended beyond that of the nearby States? Of course, agriculture can profitably consume more phosphate in the immediately adjacent areas. The work of our experiment stations proves this without a doubt. The bottleneck of our Intermountain agricultural production, however, is not lack of phosphates or other plant foods, but lack of water. I am using the term "Intermountain" in a broad sense to include all the lands between the Rockies and the Cascades and the Sierras. In fact, on the east my comments may well apply to all that great stretch of naturally semi-arid land that lies east of the 100th meridian.

Water Supply a Limiting Factor

The average rainfall of much of this area is not more than 15 inches, and little of the area has more than 25 inches. Twenty-five inches of rainfall will produce satisfactory crops if properly distributed over the growing season. The area around San Francisco, for instance, has about the same average yearly rainfall as does central Montana. The San Francisco area receives nearly all its rainfall in the crop-growing season of about six months, so that crop needs are met. On the other hand, rainfall in Montana is spread somewhat uniformly throughout the year at about two inches a month, as compared to San Francisco's four inches or more per month during the growing season. Hence, much of Montana's agriculture must resort to irrigation.

Only a small proportion of the water necessary for the production of a crop is actually retained by the crop. Most of it is lost by transpiration through the leaves. Increasing the plant food available to a crop usually results in the production of more foliage, and consequently the necessity for an increase in the water supply in order to permit normal transpiration through the larger leaf area. Lack of sufficient water to permit normal transpiration from all the leaf area and still permit retention of sap of normal concentration will result in wilting and withered plants. When additional water cannot be furnished to the crop, it may be inadvisable to provide it with additional plant food that might result in excess moisture exhaustion due to excessive vegetative growth. In other words, the problem must be solved by taking into account all the limiting factors and balancing them to obtain the optimum results.

Fertilizer Advisable on Irrigated Crop

It may be advisable then in the intermountain area to furnish maximum amounts of plant food only to irrigated crops. I have estimated that the region normally destined to be furnished its phosphates from these western deposits includes the Dakotas, Nebraska, Colorado, Montana, Wyoming, Idaho, Utah, Nevada, and that part of Oregon and Washington that lies east of the Cascade Range. According to the latest census figures available (1934), there were about 7½ million irrigated acres in this territory. It is not logical to assume that average fertilizer consumption on this acreage would exceed 500 pounds per acre even after many, many years of education and demonstration.

If a complete-fertilizer-use economy develops, an average available phosphoric acid content of 10 per cent in this fertilizer would require less than 600,000 tons of 33 per cent phosphate rock a year. Under the most favorable conditions, increase in fertilizer consumption has always been gradual. It must be remembered that creation of new and extension

Table I.

Fertilizer Consumption in 11 Western States and in the United States

State	1920-24 Average	1925-29 Average	1930-34 Average	1935	1936	1937	1938	1939
Montana	....	68	870	3,000	3,770	4,000	5,000	5,000
Idaho	340	464	1,920	3,000	3,000	4,417	9,015	6,500
Wyoming	....	270	690	1,308	1,300	1,400	1,500	2,100
Colorado	230	544	1,715	1,200	1,500	1,800	4,393	4,578
New Mexico	780	1,384	1,109	1,636	2,667	3,218	2,240	2,243
Arizona	425	780	2,320	3,393	4,000	10,500	6,500	7,000
Utah	300	510	1,560	750	2,000	2,000	2,000	2,300
Nevada	28	30	148	500	500	500	500	500
Washington	5,400	14,490	18,900	21,100	23,300	28,000	27,000	23,750
Oregon	6,900	9,300	11,780	13,000	14,300	15,000	14,500	12,750
California	70,384	106,793	135,337	178,701	207,244	232,795	208,353	219,523
Western	84,787	134,633	176,349	227,588	263,581	303,630	281,001	286,244
United States	6,195,985	7,501,002	5,890,420	6,274,364	6,901,650	8,195,506	7,488,800	7,589,349

of old reclamation projects—public and private —will increase our arable lands in the West, thus enlarging the fertilizer market as time goes on. But even in the cotton and tobacco sections of the Southeast, where land has been cropped continuously for 200 years or more, consumption rarely increased as much as 10 per cent a year. Usually decades pass before maximum consumption is reached in any new area.

Such a situation is not wholly satisfactory to the fertilizer industry, because it is anxious to open new markets for its products. We have spent millions of dollars to expand the market, sometimes in the face of rather severe opposition. This western field has been explored as a new market for fertilizers, time and time again. Likelihood of sufficient consumption to justify the erection of additional acidulating plants has apparently been lacking. At any rate, none have been constructed in recent years. The mine at Conda and the super plant at Anaconda have supplied fully, and on a parity with world prices, all the phosphoric acid and more that the adjacent and even more distant markets have called for. It is doubtful if an acidulating plant producing 20 per cent superphosphate can economically operate at less than 25,000 tons annual capacity. Even a small additional plant would be likely to create uneconomic over-supply in this area.

Concentrated Phosphates

In estimating the possibilities of expansion for the western phosphate rock industry, all possible products must be considered. Doctor Jacob discussed some of these possibilities this morning.

At the present time practically all of the available phosphoric acid used in this part of the country is in the form of concentrated superphosphate, almost always called treble superphosphate, its trade name, containing approximately 45 per cent available P_2O_5. Because of long freight hauls and scattered consumption, only high analysis superphosphates have been economically feasible here. In sections of intensive fertilizer consumption, superphosphate containing from 18 to 20 per cent available phosphoric acid has proven to be more economical and oftentimes somewhat more effective because of its higher content of calcium and sulphur—elements sometimes deficient in soils. Concentrated superphosphate is an excellent source of available phosphoric acid, and I commend highly the executives, engineers, and chemists whose foresight, ability, and ingenuity have made it possible, by achieving such a low cost of production, for the farmers of the Intermountain States to make use of this material to their economic advantage. It has been a fine example of the functioning of private initiative in a democracy.

Another concentrated phosphatic material, calcium metaphosphate, containing approximately 62 per cent of phosphoric acid, has been manufactured to the extent of several thousand tons by the Tennessee Valley Authority of Muscle Shoals. This material is in process of being tested out in field tests in many States. In soils of comparatively high acidity, the preliminary reports indicate satisfactory availability of the phosphoric acid as a plant food. As has been shown by other speakers on this program, in alkaline soils or soils approaching neutrality the results have not been too encouraging. Reports from the Idaho and Montana Agricultural Experiment Stations indicate that the phosphoric acid content of this material is not nearly so effective as is the phosphoric acid of concentrated superphosphate. Some of the experiments show no increase at all from metaphosphate, where superphosphate produced as high as 30 per cent increase in crop production. It seems apparent that calcium metaphosphate has not yet found a safe place as a promising source of available phosphoric acid for this section where alkaline soils predominate. Results have been irregular and conflicting, indicating the need for much additional research.

Other Plant Foods Needed

Although this discussion is concerned primarily with phosphates, adequate consideration of the problems involved must include other plant foods. It is a matter of history that the use of one of the major plant foods to supplement soil fertility develops into the use of other plant foods as well; and in turn the use of mixed fertilizers containing nitrogen, phosphoric acid, and potash usually becomes standard practice. It may well be that new lands, when first brought into cultivation, may have a sufficiency of two of the major plant foods to grow satisfactory crops and require, to begin with, the application of only the one that may be deficient. When this deficiency is supplied, the resulting maximum crops when harvested remove large quantities of all the plant foods. As a result the curve of production trends downward after a few years. The continued addition of the one plant food originally deficient is no longer successful in maintaining production. In the long run optimum crops can be grown only by applications of all

three plant foods. Too often, however, a drop in fertility and consequent decrease in crop production is recognized only after several successive years of low returns that cannot be blamed on lack of normal rainfall or other climatic conditions. The level of fertility must be maintained if profitable crop production is to continue for long. The plant foods removed by harvested crops must be returned to the soil.

In Table II are given a few figures showing what normal crop yields require in the way of plant food.

Table II.

Plant-Food Elements, in Pounds per Acre, Removed from the Soil by Average American Crops

Crop	Yield per Acre	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium	Sulphur	Total
Corn	30 bushels grain + stover	47.9	9.1	35.6	17.3	8.5	7.5	125.9
Wheat	15 bushels grain + straw	29 6	8.4	23.2	3.2	3.4	8.1	75.9
Alfalfa	2 tons hay	94.0	9.4	74.0	74.0	14.8	9.6	275.8
Sugar beets	10 tons	32.0	7.8	63.1	15.0	5.0	3.0	125.9

A considerable part of the necessary nitrogen can be returned through the growing of legumes in a proper rotation, but in few cases can there be supplied in this way all the nitrogen that can economically be used. When deficient, depleted, or unavailable, phosphoric acid and potash can be furnished to the soil only by the addition of fertilizers. In the American system of agriculture, it has generally proven better economy to use mixed fertilizers containing the proper proportions of nitrogen, phosphoric acid, and potash to supplement the plant foods obtained from manures and legumes. About 70 per cent of the commercial fertilizer consumed in the United States is used in the form of mixtures.

Agricultural experiment station workers almost without exception appreciate the interrelationship between the different plant foods and give due consideration to these effects when interpreting experimental results. The danger lies in layman interpretation of field indications. Education along these lines cannot be stressed too much.

Possibilities of Grass Development

To my mind one of the greatest opportunities for agricultural development in the Intermountain area lies in grass. Early last month, at the Western Grassland Conference held in Salt Lake City, many nationally known authorities discussed this problem. As Dr. P. V. Cardon, Assistant Chief of the Bureau of Plant Industry, then said: "The West grew up on grass. The West is today, and will continue to be, dependent on grass . . . . We might even say that, excepting only the soil and water upon which it thrives, grass is the West's most valuable natural resource." Dr. Walter P. Cotton, of your own University here in Utah, said: "The greatest need of the moment besides rain is for science and industry, in a spirit of tolerance and cooperation, to seek any and every measure of land management which gives promise of restoring our ranges to their proper status of renewable resource . . . . "

In recent years enormous progress has been made in many of the areas east of the Mississippi in grassland improvement. Grass-growing soils in that section are in the main sadly deficient in phosphoric acid and lime. Suitable applications of these materials have doubled the carrying capacity of pastures in hundreds of cases. In this area there are many valley areas whose natural soil water is sufficient to grow much more grass than is presently being produced. Plant food of one kind or another, most probably phosphoric acid, is the limiting factor. Proper fertilization of such areas will result in earlier and increased grazing capacity or increased hay crop for winter feed. These comments apply to both public and private lands.

No States outside the Intermountain area face the same problems in agriculture as present themselves to the States in that area. California perhaps more nearly approaches the conditions than any other. That State has mountains and deserts, sections of abundant, well-timed rainfall, and sections where only irrigation will grow a crop. It is comparatively a new State in the use of fertilizer. The average composition of the plant food consumed in that State is equivalent to a mixed fertilizer averaging 12.60 nitrogen, 6.85 phosphoric acid, and 3.07 potash. With the exception of temporary setbacks because of climatic abnormalities or financial depressions, the consumption of fertilizer has steadily increased from 41,000 tons in 1910 (earlier than which date figures are not available), to approximately 220 000 tons in 1939. In 1934 only 18.34 per cent of the fertilizer used in California was in the form of commercial mixtures, while in 1939 mixtures accounted for

(Continued on page 24)

Pacific Coast Borax Company Celebrates 50th Anniversary

Marking the completion of a half century of service in one of America's most colorful industries, the Pacific Coast Borax Company will celebrate its golden anniversary through October, the company has announced. Simultaneously, the company will observe the tenth anniversary of its radio program, "Death Valley Days," oldest half-hour dramatic program on the air.

"Coincidentally, the fiftieth anniversary will celebrate the famous company trade-mark which has captured the imagination of generations of Americans," F. M. Jenifer, president, also stated. "The 'Twenty Mule Team,' inextricably associated in the public imagination with the pioneer days of our country, is as familiar to millions as the names of great Americans. It is equally a symbol of the leadership assumed early in the history of the Borax industry by the Pacific Coast Borax Company.

"In fact the progressive history of the Borax industry in this country has been largely the history of the Pacific Coast Borax Company, pioneer in the industry," it was also stated. "Incorporated in 1890, the company has been constantly engaged for half a century in the discovery, mining, refining of Borax and in the development and manufacture of Borax products, it was pointed out, and is today the largest unit in an industry whose products are finding constantly greater application.

"In the span of 50 years since the company has incorporated, it has seen the use of Borax steadily increase from drug purposes until today this product of the desert has countless essential uses in the home, in agriculture, and in industry. Due to constantly greater demand for Borax, greater production, and improved mining, refining and transportation methods, bulk prices of Borax for industrial uses have been progressively lowered; Borax prices in the latter part of the 19th century were 1,200% higher than they are today. Total consumption has increased from only a few hundred pounds a year to thousands of tons annually. The company is proud of its record in the Borax industry."

Although incorporated in 1890, the history of the Pacific Coast Borax Company may be said to have begun on a day in 1881 when Aaron Winters, an aging prospector, together with his half-Spanish wife Rosie discovered Borax in the dry desert marshes on the floor of Death Valley. Trembling with hope, Winters fired the chemical used to identify Borax, then shouted, "She burns green, Rosie! We're rich!" Winters sold his claim to W. T. Coleman of San Francisco who established the Harmony Borax Works near the mouth of Furnace Creek. It was to carry the precious Borax ore from Death Valley across more than 160-miles of blistering desert to the railroad at Mojave that the great twenty-mule team trains were developed. Probably the largest wagons ever built, two of them together were capable of transporting 24 tons of Borax, equal to a railroad carload.

From the time Borax works were established in Death Valley the history of the Pacific Coast Borax Company has been the story of the search for new and richer ore deposits and the development of efficient means of Borax transportation and of improved mining and refining methods. Subsequently new deposits of borate of lime called Colemanite were discovered in ore form which was purer and also more easily worked than surface deposits, and the company moved its operations to Borate, Cal., convenient to the Sante Fe Railroad in the Calico Mountains southwest of Death Valley. Here what is believed to have been the first calcining plant in California was established, ore being carried over a narrow gauge railroad from mine to plant in small cars drawn by a sturdy little locomotive named "Francis".

When the borate deposits at this location had been worked out, the company again moved back into the vicinity of Death Valley, mining borate minerals in the Black Mountains and Funeral Mountains in and around Ryan, Cal. With the construction of the Tonopah & Tidewater Railroad which skirts the Eastern rim of Death Valley, first railroad to penetrate the Death Valley region, a 20 mile narrow gauge railway was built from Death Valley Junction to the company's mines. Known as the Death Valley Railroad, it was considered one of the engineering marvels of its day because of the steep grades, the rough character of the country, and the dangers from cloudbursts which had to be overcome.

It was not until 1927 that the Pacific Coast Borax Company moved to its present location at Boron, near Kramer, California, more convenient to the seaboard, where a large deposit of borate of soda known as Rasorite had been discovered by C. M. Rasor, the company's field engineer. From the calcining plant at Boron, Borax ore today is transported to one of the country's largest Borax refineries at Wilmington, Cal., where it is refined, manufactured into 20 Mule Team products, and shipped throughout the world.

September Crop Report

More favorable weather during August has materially improved production prospects over wide areas of the United States, the September estimates of the Crop Reporting Board show. With good growing conditions reported in the Cotton Belt and in the spring wheat States, and with generous rains breaking the drought in nearly all of the Corn Belt, crop yield prospects improved 5 per cent during August. Yields per acre are now expected to be about 1 per cent higher than those harvested last year and 16 per cent above the 10-year (1929-38) average.

Although several crops are late and in danger from early frosts or wet weather, an abundant harvest now seems almost assured. Prospects for wheat and corn, as well as for all food grains and all feed grains combined are now above average. The tonnage of hay and forage saved may be a new record and will be in excess of current needs. Cotton is expected to yield about a half bale per acre for the second time on record and total production is expected to be only 6 per cent below the 10-year average. The legumes—beans, soybeans and peanuts—will probably show a new high total. Tobacco will be below average but will be ample following last year's outstandingly large crop. Sweet potato production may be 5 or 6 million bushels below average but Irish potatoes will probably be 16 million bushels above average. Sugar crops are well above average and the grass and clover seed crops so far estimated show no shortage. Fruit production, though low compared with production last year, will probably be ample. Commercial vegetable production, which has been increasing rapidly, will be large even though it may not be much above production last year.

There were widespread regional changes in growing conditions during August and large changes in prospects for individual crops. The storms along the Louisiana and Carolina coasts caused losses of rice, tobacco, peanuts, and peaches; but liberal rainfall and moderate temperatures in northern and central portions of the Corn Belt and in the Southwest, caused marked improvement in prospects for corn, sorghums, and small grains, and some improvement in late hay crops, southwestern beans, flax, potatoes, and other late crops. Pastures, and ranges were revived over a wide area, and greatly improved conditions for seeding winter wheat in Kansas and the Southwest were reported. On the other hand, dry weather continued through August into early September in an area extending from east central Nebraska and central Colorado northwestward, and continued until late in August in another area extending from central Illinois and Kentucky to New England. Lack of rainfall in these sections damaged soybeans, apples, and other late crops and caused a rapid decline in the condition of local pastures and ranges.

With generally favorable conditions, however, the forecast of grain sorghum production was increased 20 per cent during August. The cotton estimate increased 12 per cent, spring wheat 11 per cent, oats 8 per cent, barley and flax 5 per cent each; beans 3 per cent, corn, potatoes, and sweet potatoes, each about 2 per cent; and hay and sugar beets 1 per cent each.

Crop	Total Production (in thousands)		
		Indicated	
	1939	Aug. 1, 1940	Sept. 1, 1940[1]
Corn, all, bu.	2,619,137	2,248,246	2,297,186
Wheat, all, bu.	754,971	760,623	783,560
Winter, bu.	563,431	555,839	555,839
All spring, bu.	191,540	204,784	227,721
Durum, bu.	34,360	34,179	35,599
Other spring, bu.	157,180	170,605	192,122
Oats, bu.	937,215	1,121,619	1,206,901
Barley, bu.	276,298	289,812	304,955
Rye, bu.	39,249	37,452	37,452
Buckwheat, bu.	5,739	5,993	5,707
Flaxseed, bu.	20,330	29,279	30,662
Rice, bu.	52,306	55,071	52,280
Grain sorghums, bu.	83,102	105,095	125,793
Hay, all tame, ton	75,726	83,383	84,125
Hay, wild, ton	8,800	8,760	8,927
Hay, clover and timothy,[2] ton	23,640	28,261	28,392
Hay, alfalfa, ton	27,035	29,851	30,258
Beans, dry edible, 100-lb. bag	13,962	14,649	15,133
Peas, dry field, bu.	3,713	.....	3,292
Soybeans for beans, bu.	87,409	.....	85,509
Peanuts,[3] lb.	1,179,505	1,521,705	1,511,150
Potatoes, bu.	364,016	374,314	383,172
Sweet potatoes, bu.	72,679	65,673	66,894
Tobacco, lb.	1,848,654	1,262,087	1,241,680
Sugarcane for sugar, ton	6,197	5,609	5,346
Sugar beets, ton	10,773	10,553	10,649
Broomcorn, ton	30	40	42
Hops, lb.	[4]39,380	39,460	39,280
Apples, com'l crop, bu.	143,085	116,721	114,830
Peaches, total crop, bu.	[4]60,822	53,290	52,879
Pears, total crop, bu.	[4]31,047	31,372	32,008
Grapes,[5] ton	2,526	2,489	2,500
Pecans, lb.	63,639	73,665	76,651

[1] For certain crops, figures are not based on current indications, but are carried forward from previous reports.

[2] Excludes sweetclover and lespedeza.

[3] Picked and threshed.

[4] Includes some quantities not harvested.

[5] Production includes all grapes for fresh fruit, juice, wine, and raisins.

An Expanding Fertilizer Industry

By A. W. BLAIR

Professor Emeritus, New Jersey College of Agriculture, New Brunswick, N. J.

(Continued from the September 14th Issue)

Period III. 1880-1900

This period was one of gradual growth and expansion. Extensive deposits of phosphate were opened in Florida in 1888, and in Tennessee in 1894. Importations of potash salts from Germany, and of nitrate of soda from Chile increased. Through federal grants, Experiment Stations were being established in a number of the States, and through the work of these stations, farmers were taught the value of fertilizers, and how to use them.

The Association of Official Agricultural Chemists, which was organized in 1884 and which represents the State control work, was active in the wider introduction of control laws, in establishing standards, and in improving the official methods of analysis. The fertilizer manufacturers were gradually extending their territory into the middle west where fertilizers were formerly unknown, and progressive farmers in this section were beginning to learn that their soils were not inexhaustible, and were manifesting a willingness to cooperate with State and federal agencies in proving the value of commercial fertilizers.

This period saw the development of by-product ammonia, through the use of recovery ovens in the coking of coal. It was during this period also that cottonseed meal was widely used as a fertilizer, especially in the South, its value as a feeding material not yet having been fully appreciated. It was during the closing years of the century that scientists began the research and experimental work, which finally, in the early years of the 20th century, led to the working out of successful methods of fixing atmospheric nitrogen. Thus were fulfilled the hopes and prophecies of those who, earlier, had dreamed of such possibilities. Without question this work was encouraged and hastened by the now famous statement of Sir William Crooks, before the British Association for the Advancement of Science in 1898, to the effect that if some other method of obtaining fixed nitrogen than was then known, could not be found, then the world would soon go hungry for bread. But already scientists were at work on the problem and development came rapidly in the early years of the 20th century.

Period IV. 1900-1940

As mentioned above this was the period of development of methods, and the successful fixation, synthetically, of atmospheric nitrogen. Through this work an age-long problem was solved. No longer would a shortage of fixed nitrogen threaten starvation. The solution of this problem led to many new developments in the fertilizer industry.

With an abundance of fixed nitrogen in the form of nitric acid and ammonia, it was possible to produce a whole new series of fertilizer materials not previously in use. With these new materials it was possible to make high-grade chemical fertilizers having excellent physical properties. This improvement in physical or mechanical condition has resulted in greatly improved methods of applying fertilizers. The granulation of fertilizer materials and mixed fertilizers has also contributed largely to more uniform distribution. It was during the early years of this period that there was developed a method for processing crude organic nitrogenous materials such as leather scraps, hair, wool waste, feathers, etc., in such a manner as to convert most of the protein nitrogen into an available form of ammonia. This was a long step forward, and resulted in salvaging, for the fertilizer industry, a large amount of waste and by-product materials which before were of little value, and indeed were frequently banned from use by State law.

Parker[7] has shown that between 1850 and 1880 the consumption of fertilizer nitrogen was very small, and that since 1880 it has gradually increased to a total of 433,000 tons for 1937. See Fig. 1. This figure also shows how fertilizer nitrogen in the form of natural organics reached a maximum about 1920, and thereafter has gradually decreased, while at the same time the total nitrogen and also the inorganic nitrogen (including the synthetic organics) have rapidly increased. This last change has been brought about very largely by the low price of synthetic ammonia, and also by the increased

[7] Parker, F. W. Consumption of Fertilizer Nitrogen in the United States. Agricultural News Letter (du Pont) Vol. 8, No. 3 (May-June, 1940).

(Continued on page 22)

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Report of 1939 Fertilizer Sales Shows Trend Toward Fewer Grades

Fewer grades of fertilizer, and larger tonnage of mixtures containing high proportions of plant foods are progressive tendencies evident in the results of a survey and analysis of fertilizer sales in 1939. Both these trends have been recommended by State and Federal experimenters as desirable, and of advantage both to farmers and to manufacturers. The U. S. Department of Agriculture investigators, A. L. Mehring and Lola S. Deming had the cooperation of Herbert Willett of the National Fertilizer Association in assembling the figures, which are more nearly complete than those in any previous report of this kind. Their analysis of the results has just been published by the association as a special bulletin.

Fertilizer sales for 1939 amounted to 7,616,000 tons. The survey gives details of the kinds and grades of more than 90 per cent of this, or 6,905,984 tons. The most comprehensive previous survey, for 1934 covered only about 78 per cent of sales for that year. State records were used wherever reliable reports were available and were reorganized for uniform presentation and tabulation. Half the states now have records of fertilizer sales suitable for such a study as compared with only 15 states in 1934. Where official records were not available, questionnaires were sent to all dealers handling fertilizers.

Nearly a thousand grades (982) were reported, and the mixtures in the remaining 10 per cent would bring the total grades to more than a thousand. This compares, however, the investigators point out, with 1,291 grades in the 78 per cent of the fertilizers reported on in 1934.

Gains in the content of plant food in fertilizer mixtures for 1939 are reflected in the tabulation of the weighted average. This records substantially what would have resulted if all the mixed fertilizers had been mixed together in one uniform mixture. Expressing the plant food units in decimals instead of in the whole numbers usual in fertilizer grades, for 1939 the average grade designation would be 3.76-9.08-5.78 compared with 3.52-8.75-5.12 for 1934, showing increases in each of the main plant foods, nitrogen, phosphoric oxide, and potash.

Ten states bought more than a quarter million tons each of fertilizer in 1939, with North Carolina well in the lead with more than a

million tons (1,107,347). Four other Southern States exceeded a half million—Georgia, 736,179 tons, South Carolina 672,753, Florida 556,782, and Alabama 531,000. Virginia used 418,973 tons folowed by Pennsylvania, 356,853, Ohio 345,585, and New York 323,980, with Mississippi tenth with a consumption of 285,667 tons.

Florida reported sales of more grades than any other state—at least 360, and South Carolina and Puerto Rico also reported great variety in mixtures. This year, however, Puerto Rico will choose from not more than 54 grades eligible to registration under new regulations. Of the states using large supplies of fertilizers, Alabama and Mississippi reported fewest formulas with only 12 each. As recently as 1934 Alabama reported 60 grades. Alabama's record is regarded as outstanding, with farmers concentrating purchases on a 6-8-4 fertilizer particularly recommended by the State Experiment Station as desirable for many Alabama conditions.

For the country as a whole, the leading fertilizer formula was 3-8-5 superseding 3-8-3 which led in popularity in 1925 and 1934. Up to about 1920 the relatively low analysis mixture 2-8-2 led in tonnage, but is now low in rank and going out of use. The 1-8-4 grade once popular is no longer listed separately. The second most popular grade last year was the 20-unit mixture, 2-12-6, which is gaining widely and may soon pass the 3-8-5. This grade was not listed in 1917 and stood 28 in order of tonnage consumed in 1925.

Vermont is leading the trend toward use of high analysis fertilizers with more than one-sixth of its fertilizer in the 40-unit grade, 8-16-16. Maine ranked highest in the average of plant food units in its fertilizers, slightly less than 30. and South Carolina lowest with an average of only 16.04 units. Maine also used the largest proportion of mixed fertilizer.

The survey distinguishes between mixed fertilizers and fertilizer materials. In both groups, however, the survey notes a definite upward trend in the strength of plant foods to the ton. In general, all materials and mixtures contributing less than 16 units of plant food to the ton are losing popularity because cost of bagging and transportation is relatively high per unit.

Standardization of grades offers opportunity for economics in manufacture, storage, and in stock requirements to supply demand. The survey shows that farmers are making progress in concentrating their purchases on fewer grades. In most states the leading grade now accounts for more than one-fifth of all the fertilizer sales, and in Mississippi, Missouri, Oklahoma, Ohio, Indiana, and Michigan—as well as in several western states where consumption is light—a single grade accounted for more than half of all the mixed fertilizers sold in 1939.

The use of higher analysis grades of potash fertilizer materials has more than doubled since 1934, the report notes. Potash gains are particularly striking in the northern states. The phosphoric acid percentages of superphosphates are generally on the up-grade in most sections with consumers learning that it is cheaper per unit of plant food to buy the higher grade materials.

A series of 14 comprehensive tables is included in the publication, which is regarded as giving a fairly complete picture of the present situation with respect to fertilizer consumption in the United States.

BARRETT PAMPHLET ON FALL GRAINS

"Well-begun is half-done." This is the theme of a new pamphlet on the fertilizing of winter grains in the southeastern states, which has recently been published by The Barrett Company. Entitled "Prepare in the Fall for Grain in the Spring," the pamphlet shows by statistics and illustrations the need for applications of mixed fertilizer when planting winter grain in the fall, to be supplemented by top dressing of nitrate of soda in the spring.

Unless the crop immediately preceding has been extremely well-fertilized, there is seldom enough available phosphorus and potash, as well as nitrogen, in southeastern soils to give fall grains the proper initial root and stalk development to carry over the winter and thus to give full response to the spring top-dressing. Farmers using 200 or 300 lb. of complete fertilizer at planting time were provided with extra winter grazing which often paid the full cost of the fertilizer; in addition, after spring application of nitrate of soda, the increased crop of grain harvested provided further dividends.

The average results of many tests on oats in the Carolinas, Georgia and Alabama showed an increase of 8.1 bushels per acre where only a spring top-dressing of 100-lb. of nitrate of soda was applied, but an increase of 20 bushels where 200-lb. of complete fertilizer was used in the fall, along with 100-lb. of nitrate in the spring. Increasing the top-dressing to 200-lb. of nitrate increased the yield by another 11.7 bushels.

Copies of the pamphlet can be obtained from any of the Barrett offices.

August Tag Sales

FERTILIZER sales in August in 17 States amounted to 161,600 tons, according to reports of tag sales by State control officials to The National Fertilizer Association. This represented increases of 4 per cent over last year and 26 per cent over two years ago. An increase in the South as compared with August, 1939, more than offset a decline in the Midwest. Total sales in the January-August period were moderately larger than in the corresponding period of each of the last two years but were well below 1937.

Aggregate sales in the southern States in August were 41 per cent larger than a year ago, with 9 of the 12 States reporting increases. With the exception of Florida, August sales in the South are comparatively small. The seasonal low point is reached in July and August, with each month accounting for about 1 per cent of the annual total.

Missouri was the only one of the 5 States in the Midwest to report an increase in August sales over last year. The decline for the region as a whole was 10 per cent. In earlier months sales had been well above last year's level; sales in the first 8 months were 11 per cent above 1939, with each of the States showing an increase. Sales have also been above 1937, the recent peak year.

FERTILIZER TAX TAG SALES

State	August				January-August			
	1940		1939	1938	1939-40		1939	1938
	Per Cent of 1939	Tons	Tons	Tons	Per Cent of 1939	Tons	Tons	Tons
Virginia	151	18,445	12,199	17,150	95	313,821	329,627	319,961
N. Carolina	104	4,220	4,073	1,500	88	975,825	1,108,955	1,003,546
S. Carolina	76	1,920	2,525	2,355	100	638,574	638,914	627,189
Georgia	130	1,890	1,458	1,064	107	714,663	666,202	700,283
Florida	149	27,777	18,697	15,899	110	334,661	303,486	308,600
Alabama	300	1,950	650	450	103	562,050	547,300	522,000
Mississippi	350	700	200	475	106	293,295	277,846	298,636
Tennessee	618	2,225	360	3,862	106	123,873	116,679	113,977
Arkansas	75	300	400	250	143	93,750	65,372	62,850
Louisiana	40	850	2,150	1,250	106	133,531	125,728	125,222
Texas	145	400	275	150	128	103,581	81,009	72,122
Oklahoma	...	105	5	400	91	5,853	6,403	7,080
Total South	141	60,782	42,992	44,805	101	4,293,477	4,267,521	4,161,466
Indiana	82	55,700	67,694	62,000	111	253,944	228,508	202,609
Illinois	70	4,462	6,362	5,195	113	40,660	36,087	35,412
Kentucky	78	7,489	9,550	2,650	102	104,189	102,106	97,548
Missouri	139	29,315	21,084	10,156	132	55,580	42,017	34,965
Kansas	54	3,885	7,171	3,895	101	8,683	8,626	7,462
Total Midwest	90	100,851	111,861	83,896	111	463,056	417,344	377,996
Grand Total	104	161,633	154,853	128,701	102	4,756,533	4,684,865	4,539,462

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FERTILIZER MATERIALS MARKET

NEW YORK

No Important Changes in Material Prices. Supplies of Most Materials Adequate. Chesapeake Menhaden Output Continues Good.

Exclusive Correspondence to "The American Fertilizer."

NEW YORK, September 24, 1940.

The past two weeks have shown no important changes in the raw fertilizer materials market, and most materials are in a firm position and holding recent gains. Although buying activity is normally small at this time of year, asking prices are up a bit and sellers are maintaining firm ideas.

With the exception of sulphate of ammonia, supplies of all materials are adequate and no shortages are anticipated in the near future.

A few sales have been reported in the export market, but there have been practically no new inquiries from this market during the past two weeks.

Nitrate of Soda

September schedule prevails at $29.00 per ton in 100-lb. bags, $28.30 in 200-lb. bags, and $27.00 in bulk; ex warehouse, port basis. Supplies are ample.

Sulphate of Ammonia

Continues to be in strong demand and short supply. Price, when obtainable, held at the announced schedule of $28.00 per ton in bulk, usual Atlantic and Gulf Ports. Several export sales have been reported recently, but demand from this direction is now limited.

Superphosphate

The market for ordinary superphosphate is unchanged and remains firm. Triple superphosphate is very scarce and practically none of this material is available for export.

Potash

Market strong with regular schedule price of 53½ cents per unit of K_2O, less seasonal discount, prevailing.

Dried Blood

Continues to be firm. One small parcel has recently been bought for shipment from South America at $2.50 ($3.04 per unit N), and South American spot material can be bought for $2.60 ($3.16 per unit N). Domestic productions are being quoted at $2.50 ($3.04 per unit N).

Tankage

Local material is available at $2.40 ($2.91½ per unit N) and 10 cents. South American productions are being quoted at $2.75 to $2.90 ($3.34½ to $3.52½ per unit N) and 10 cents, depending upon grade.

Nitrogenous Material

Activity confined to contract deliveries, and price is strictly nominal on the same basis that has prevailed for the last several months.

Bone Meal

Supplies of domestic material scarce and there are practically no offerings. South American 4½ and 50 per cent grade can be bought at around $32.00, c.i.f.

Fish Scrap

The Chesapeake Bay fishing continues to be quite good. Further bookings on an "if and when made" basis have been reported at $3.15 ($3.83 per unit N) and 10 cents. Menhaden meal is nominal at $47.00, Baltimore basis.

Soya Bean Meal

Crushers are awaiting receipt of new beans which will begin moving next week. Meanwhile, they are quoting for delivery November/forward at $19.50 per ton in bulk, f.o.b. Decatur, Ill. This price is equivalent to $27.60 delivered New England points and $27.20 delivered New York area.

The Roxboro Chemical Corporation, with principal offices in Roxboro, N. C., has been chartered to manufacture and sell fertilizers, chemicals, insecticides and other ingredients. The initial capital is $100,000.

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CHICAGO

Little Inquiry for Fertilizer Organics but Prices Remain Firm. Feed Market Inactive.

Exclusive Correspondence to "The American Fertilizer."

CHICAGO, September 23, 1940.

Restriction of inquiry for organics is unchanged. This condition should right itself when we are closer to the coming season. Meanwhile no lower offerings are noticeable, sellers being in comfortable position. Demand for steamed bone has dwindled, but asking prices are maintained, supply being exceedingly light.

The edge appears off in the feed materials market. Demand has narrowed, and buyers refuse to reach for supplies at sellers' asking prices.

Nominal prices are as follows: High-grade ground fertilizer tankage, $2.00 to $2.25 ($2.43 to $2.73½ per unit N) and 10 cents; standard grades crushed feeding tankage, $2.60 to $2.65 ($3.16 to $3.22 per unit N) and 10 cents; blood, $2.65 to $2.75 ($3.22 to $3.34½ per unit N); dry rendered tankage, 52½ to 60 cents per unit of protein, Chicago basis.

ATLANTA

Greater Activity Reported with Smaller Companies in the Market. Prices Generally Unchanged but Sensitive to World Changes.

Exclusive Correspondence to "The American Fertilizer."

ATLANTA, September 23, 1940.

With the approach of fall the fertilizer materials market is beginning to show some sign of reviving, although the trade is by no means active. Most of the primary articles which are sold under term contracts have been pretty well booked ahead, but many of the smaller manufacturers are beginning to look around for supplies. The markets generally are unchanged from our last report, but they are all very sensitive to world changes, and prices will be quick to reflect any marked change in the present status of world events.

There is some indication of an advance in the price of nitrate of soda, but it has not been announced as yet. Sulphate of ammonia is in good demand with limited supplies. The current markets are as follows:

Tankage.—Imported, $2.60 ($3.16 per unit N) and 10 cents, c.i.f.

Blood.—Imported, $2.60 ($3.16 per unit N), c.i.f.

Fish Scrap.—Menhaden, $3.15 ($3.83 per unit N) and 10 cents, Chesapeake Bay.

Acidulated Scrap.—Nothing offered.

Sulphate of Ammonia.—No change.

Nitrate of Soda.—No change.

Cottonseed Meal.—Prime 8 per cent, $21.00 to $21.50, basis f.o.b. Memphis.

Steam Bone Meal.—3 and 50 per cent, $31.00, c.i.f.

Raw Bone Meal.—4½ and 45 per cent, $31.50, c.i.f.

BALTIMORE

Market Quiet But Prices Remain Unchanged. Shortage of Sulphate of Ammonia Continues. Menhaden Catch Satisfactory.

Exclusive Correspondence to "The American Fertilizer."

BALTIMORE, September 24, 1940.

The market on fertilizer materials during the past two weeks has been more or less along routine lines, with interest in further supplies at a minimum, in spite of which, however, the market remains firm and practically unchanged.

Ammoniates.—The market remains unchanged, and ground animal tankage is nominally $2.80 to $2.90 per unit of nitrogen. South American ground dried blood is ruling slightly easier at about $3.02 per unit of nitro-

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gen, but with practically no business passing.

Nitrogenous Material.—This ingredient is still in light demand, and the market remains unchanged at $2.55 to $2.65 per unit of nitrogen for the domestic product.

Sulphate of Ammonia.—While steel mills are running practically at capacity, most fertilizer manufacturers have not been able to cover for much more than 50 per cent of their requirements and the export market is fully $10.00 per ton above the schedule announced at the opening of the season for domestic consumption.

Nitrate of Soda.—The demand continues seasonably light, and while domestic producers have not yet announced prices for bagged nitrate for October and forward shipment, importers of the Chilean continue to book business at $29.50 per ton of 2,000 lb., in 100-lb. bags, or $28.80 in 200-lb. bags, ex port warehouse.

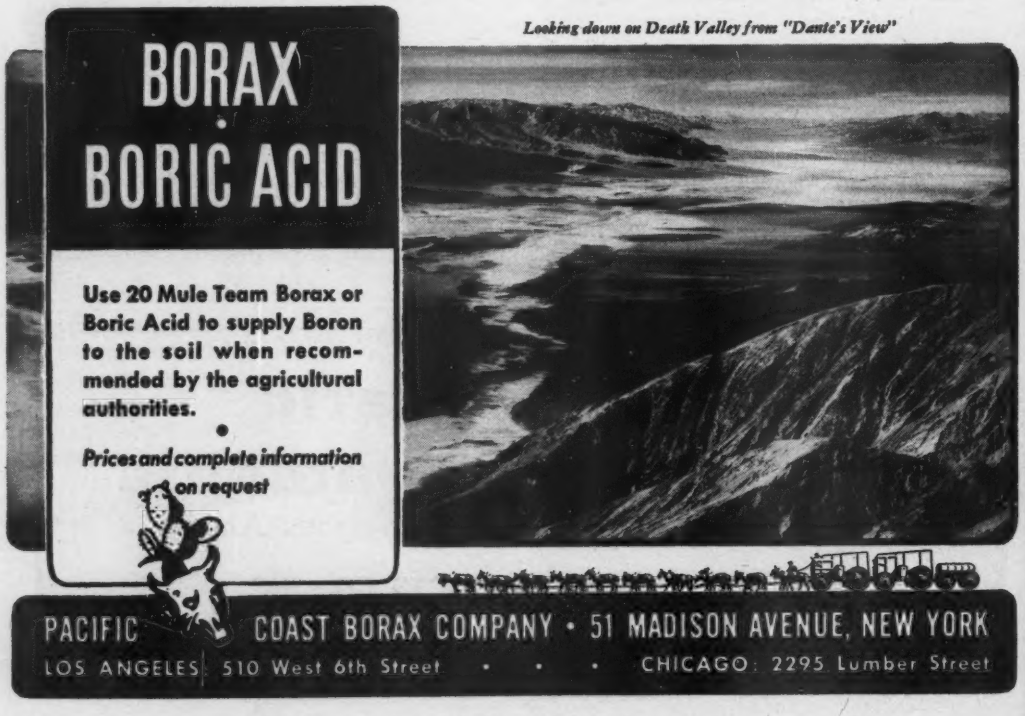
Fish Scrap.—There has not been any change in the market and last sales were on the basis of $3.75½ per unit of nitrogen and 10 cents per unit of B.P.L., f.o.b. fish factories. It is reported that producers expect to complete all contracts on their books at the present time, and no shortage is anticipated. Shipments of Japanese sardine meal are slowing up considerably, but stocks are more than ample for current requirements due to heavy summer shipments which are being held for later delivery.

Superphosphate.—It is anticipated that the demand for sulphuric acid for national defense will be felt before long, and this may have some effect on the future market on superphosphate. Present prices remain unchanged at $8.50 per ton of 2,000 lb., for flat 16 per cent grade, and $8.00 for run-of-pile, basis 16 per cent, both in bulk, f.o.b. sellers' works, Baltimore.

Bone Meal.—The market on both raw and steamed bone meal continues quiet and unchanged without any business passing. The nominal market on 4½ and 47 per cent South American raw bone meal is $31.00 to $32.00 per ton, while domestic 3 and 50 per cent steamed bone meal is quoted at $32.00 to $34.00 per ton, f.o.b. Baltimore.

Potash.—There is practically no activity on this commodity at the present time, and probably will not be until the spring season is well under way, by which time domestic producers expect to be in position to take on further business to take care of normal domestic requirements.

Bags.—The burlap market continues firm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New York, N. Y.
Norfolk, Va.
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San Juan, P. R.
Sandusky, Ohio
Wilmington, N. C.

with advancing tendency. The present price of plain, new, 10-oz. bags is about $112.00 per thousand, basis 40 cut 54 in., delivered Baltimore, for spring delivery.

PHILADELPHIA

Market Remains Slow. Improvement in Deliveries of Nitrate of Soda Shown.

Exclusive Correspondence to "The American Fertilizer."

PHILADELPHIA, September 24, 1940.

The fertilizer materials market continues slow. There is no activity in any particular material except possibly nitrate of soda where there has been a slight improvement in deliveries, due, no doubt, to the increase in price beginning October 1st.

Nitrate of Soda.—Price effective Oct. 1st, $27.00 in bulk; $28.80 in 200-lb. bags and $29.50 in 100-lb. bags.

Sulphate of Ammonia.—Firm. Shipments being made on contracts as scheduled.

Dried Blood.—Quiet. Being offered at $2.50 ($3.04 per unit N) but not much interest being shown.

Tankage.—Same conditions prevail as with blood.

Bone Meal.—Steady and unchanged. 1 and 65 per cent at $32.00 to $33.00; 3 and 50 per cent at $32.00 to $34.00; 4½ and 45 per cent at $33.00 to $34.00.

Superphosphate.—Price unchanged.

Potash.—Schedules prevail.

I. A. C. SALES OFFICE MOVED

The Boston sales office of the International Agricultural Corporation has been moved from 38 Chauncy St., Boston to the Company's plant at Woburn, Mass.

WILMINGTON

Somewhat Greater Interest in Organics Shown. Marketable Supply of Cottonseed Meal Uncertain.

Exclusive Correspondence to "The American Fertilizer."

WILMINGTON, September 23, 1940.

There has been a little more interest shown in organic ammoniates during the past two weeks. The easier blood market has attracted some interest, and there has been a little trading in cottonseed meal. The oil mills still hesitate to make sales of meal for the future, as the farmers are taking their seed home or asking for meal trades so that the mills have difficulty accumulating any meal for sale. The large cotton crop should make for lower meal prices, but until the present season gets further advanced. it will be likely to hold firm.

Fishing has been very poor for a month, with buyers clamoring for deliveries of early contracts, but with no fish being caught there is nothing that the producers can do except express regret. The scrap market is very firm, for there are few producers who are interested at present in making commitments further.

As the tobacco marketing season progresses, the price holds fairly well but it becomes more and more apparent that the poundage will be off far more than the reduction in acreage would indicate.

TENNESSEE PHOSPHATE

Severe Drought Harms Crops and Handicaps Phosphate Production. Shipments of Ground Rock Continue to Increase.

Exclusive Correspondence to "The American Fertilizer."

COLUMBIA, TENN., September 23, 1940.

Suffering from the most prolonged drought ever known at this time of the year, pastures are rapidly burning up, farmers are short or entirely out of water for stock, and several

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prominent phosphate plant operators say that with one more week of dry weather they will have to discontinue operations for want of washing water.

Corn and all row crops have suffered severely, and much alfalfa and crimson clover seed has been entirely lost and will have to be reseeded.

The shipments of ground phosphate rock to farmers for direct application to the soil have been unusually heavy for the past two months and will probably exceed the same months in 1939 by a considerable percentage, in spite of an advance in price by one of the largest shippers. This firm produces primarily high-grade product for this use and has to bear the extra costs of taxes and many other items, while their competitors, who sell only the low-grade by-product to this trade, have actually reduced their prices to get business.

As the only definite experiment showing comparative values of the high-grade finely ground product and the low-grade more coarsely ground material, which has been under way at the Kentucky Experiment Station at Princeton for the past ten years, now shows an advantage for the fine rock phosphate of over $13.00 per ton in nine years' results, it is easy to see why most farmers who are familiar with the use of ground phosphate rock, continue to pay from $1.50 to $3.00 per ton more for the high-grade product finely ground, just as No. 1 corn brings more than No. 5.

The concern recently mentioned as grinding mixtures of high-grade phosphate rock with muriate of potash in Columbia, is The Rockford Rock By-Products Co., 1100 School St., where they have a JB grinding mill and mixer, and report prospects of satisfactory business for the fall trade in Ohio, Indiana and Illinois. Sales are made entirely through elevators. They also make some mixtures with sulphate of ammonia in addition to the potash, and some experiments of the Potash Institute report results from such mixtures better than with superphosphate.

Construction of the additional furnaces at both Victor and Monsanto plants has been prosecuted with great vigor and from an outside view it appears there will be little difficulty in having the entire capacity in operation by 1941. These tremendous productions of elemental phosphorus, handled as everyday matters and actually shipped to great distances in the U. S. in tank cars, and for export as well as domestic shipments in steel drums, show the advance of chemical industry. It opens up vistas of new uses for phosphorus in this form, whenever the demand for high-priced chemicals becomes less than will take up this excess production and "the show still has to go on."

An Expanding Fertilizer Industry

(Continued from page 11)

demand for the animal and vegetable organics in the production of feeding materials.

The demand for increased crop production during the first world war greatly stimulated developments in the fertilizer industry. With the supply of foreign potash reduced, and finally cut off entirely, it became necessary to

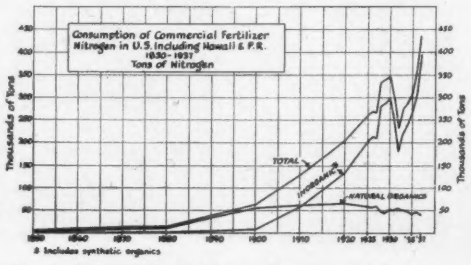

FIG. 1. Consumption of nitrogen in commercial fertilizers. (Courtesy Du Pont Agricultural News Letter)

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Information and references available on request.

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See Page 4

locate domestic sources. Such sources were brines from Searles Lake in Southern California, and shallow lakes in Nebraska, giant kelps from the Pacific Coast, alunite from Utah, flue and furnace dusts, tobacco stems, by-products from the sugar beet and sugar cane industry, etc. More recently the opening of potash mines at Carlsbad, New Mexico, and the location of mines in Texas, make the United States independent of foreign potash. According to the American Fertilizer Hand-book for 1940 the domestic production of potash for 1938 was 366,287 short tons of K_2O valued at $12,028,195. This was more than our entire annual importation previous to 1917.

Other important developments have been the production of phosphorus by the electric furnace method, the production of triple superphosphate and metaphosphate, synthetic urea, ammonium sulphate, nitrate of soda and calcium nitrate.

With these high grade materials, and high grade potash, it has been possible to satisfactorily make highly concentrated fertilizers, and thus effect a decided saving in bagging, freight and handling charges.

In recent years the work of the National Fertilizer Association in cooperation with the Experiment Stations and State Departments of Agriculture has been very effective in eliminating low-analysis, and superfluous grades of fertilizers. All these improvements have resulted in giving farmers better fertilizers, and generally at reduced cost per unit.

Economic Feasibility of Expanding the Western Phosphate Industry

(Continued from page 8)

30.95 per cent of the total. North Carolina, the heaviest fertilizer-consuming State, takes 82.7 per cent of its plant food in the form of mixtures; and Maine, which uses on the average a ton and a half of high-grade fertilizer an acre on the potato crop, uses 96.33 per cent of the total in the form of mixtures. I predict that the Intermountain States will progress from the use of materials furnishing a single plant food to mixtures containing two or more plant foods. I only hope that the knowledge of this better economy, if it proves to be such, will not be realized too late, and that the conscious direction of progress will adapt itself to the true interests of our Intermountain farmers, particularly on expensive irrigated lands.

The second main point to be considered in connection with the economics of western phosphate expansion is, can the area of consumption be extended beyond nearby States?

Cost of production plus cost of transportation are the determining factors as to how far away western phosphate can be economically utilized. Western phosphate must not only compete with that produced in Florida and Tennessee, but with that produced in North Africa, in Russia, and on Pacific islands. It is to some extent unfortunate that the western deposits are located between mountain ranges flanked by arid and semi-arid lands, so that rail transportation costs to consuming areas are considerably higher than comparable costs from the Florida and Tennessee fields. That part of California, Oregon, and Washington that lies west of the Cascades and the Sierras can be reached from Florida by water through the Panama Canal at rates as low as or lower than the rail rates from the western mines. Likewise, concentrated superphosphate, and superphosphates of lower grade, have been delivered to Pacific Coast ports from factories on the Atlantic and Gulf Coast States, from Europe, and from Japan at prices that met and sometimes were lower than the prices of western-produced material. The western rock deposits have no advantage in production costs, and no advantage in concentration. Only cheapened transportation can be looked to as the factor which may permit extension of the area of consumption.

For several years most of our railroads have been operating at a loss, so there seems little likelihood that any worth-while reduction in freight rates could be obtained. Wide geographical extension for the use of western phosphates does not seem unduly promising. Agronomic extension presents a somewhat more optimistic future. Undoubtedly, a surprisingly large acreage of the hay land and some of our western range lands could be fertilized with profit. Though dry-land culture of wheat may not present a profitable

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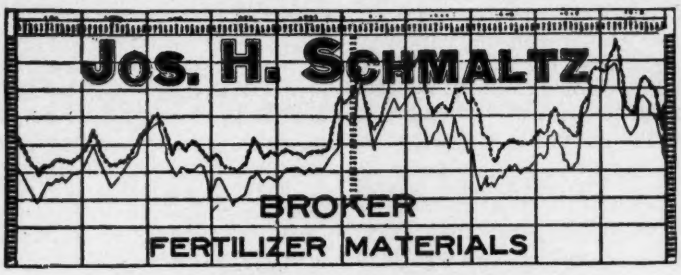

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outlet for fertilizer, it is probable that most irrigated crops could be supplied with additional plant food to the economic advantage of the grower. Certainly the sugar beet crop will respond with profit to fertilization, and probably phosphate and potash can be used to advantage on alfalfa, especially at the time of seeding to insure a stand.

In my talk I have indicated that in my opinion mixed fertilizers will probably prove better economy in the long run than single plant-food materials, especially after an initial period of experimentation, education, and soil exploitation. Before recommending the use of all three plant foods to the Intermountain farmers, perhaps we should briefly inventory in our minds the world's known supply of these materials.

Nitrogen

The production of synthetic nitrogen compounds from the air can be considered as unlimited, because each acre of the earth's surface has above it, available for fixation—either synthetically or by legumes—34,500 tons of nitrogen. This is equivalent to 148,000 tons of nitrogen for each acre of land surface. Furthermore, when nitrogen compounds decompose, whether they be in the form of explosives or in the form of the proteins in animal and vegetable tissues, the nitrogen content is again released into the air to replace that nitrogen which has been fixed either by artificial or natural processes. It is estimated that there are 200,000,000 tons of nitrate of soda left in Chile, equivalent to 33,000,000 tons of nitrogen. The production of by-product sulphate of ammonia amounts to about 400,000 tons of nitrogen annually.

Phosphoric Acid

The reserves of high-grade phosphate rock in the world are now considered much greater than heretofore estimated. Recent investigations indicate that there are at least 15,000,000,000 tons of high-grade phosphate rock in the United States, and at least 10,000,000,000 tons of high-grade phosphate rock in deposits already located in foreign countries. New beneficiation processes and furnace methods now permit the use of much lower grade rock than heretofore. It is estimated that there are at least 25.000,000,000 tons of low-grade rock suitable for processing under these methods in the United States, and at least 50,000,000,000 tons in foreign deposits already located. Astronomical figures these truly are, but they are supported by much more than mere reconnaisance surveys.

Potash

Relatively few data are available on estimated world reserves of potash. It is estimated that there are in the United States approximately 100,000,000 tons of K_2O in the areas now under development. The Permian Basin in which these areas occur is immense. New deposits are now being prospected, and undoubtedly the above figure is very conservative. In the Franco-German Stassfurt area of Europe there are estimated to be over 8,350,000,000 tons of K_2O. Extensive deposits are known to be located in Spain and in Poland, but no data are available as to their extent. From the brine content of the Dead Sea, it can be rather closely estimated that there are approximately 2,000,000,000 tons of K_2O in that body of water. Enormous deposits are known to be located in the U. S. S. R. One estimate gives a reserve of 18,000,000,000 tons of K_2O in two areas of the several claimed to be known. Such figures can only afford a basis of speculation.

Western phosphate will have an ever-expanding use and increasingly important place in the economics of western agriculture. I believe the time will come when almost every cropped acre will be fertilized. Marginal lands and areas of insufficient rainfall without the possibility of irrigation will be turned into forests or allowed to return to natural conditions under government care and at government expense, as is warranted by the national character of the problem they present.

The West must use its natural resources first of all to increase the productiveness of its own acres. By so doing it can reduce the unit cost of its crops so that they can compete in the markets of the country and of the world with the products of others. Surplus production, whether of phosphates or of farm products, must meet the untempered and often cruel winds of inevitable competition.

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Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CHEMISTS AND ASSAYERS
Gascoyne & Co., Baltimore, Md.
Shuey & Company, Inc., Savannah, Ga.
Stillwell & Gladding, New York City.
Wiley & Company, Baltimore, Md.

CLUTCHES
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CONCENTRATORS—Sulphuric Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

CONDITIONERS AND FILLERS
American Limestone Co., Knoxville, Tenn.

CONTACT ACID PLANTS
Chemical Construction Corp., New York City.

COPPER SULPHATE
Tennessee Corporation, Atlanta, Ga.

COTTONSEED PRODUCTS
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
Schmaltz, Jos. H., Chicago, Ill.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

CRANES AND DERRICKS
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Link-Belt Speeder Corp., Chicago, Ill. and Cedar Rapids, Iowa.
Sackett & Sons Co., The A. J., Baltimore, Md.

CYANAMID
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Jett, Joseph C., Norfolk, Va.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

DENS—Superphosphate
Chemical Construction Corp., New York City.
Stedman's Foundry and Mach. Works, Aurora, Ind.

Andrew M. Fairlie
CHEMICAL ENGINEER
22 Marietta Street Building ATLANTA, GA.
CABLE ADDRESS: "SULFACID ATLANTA"

SULPHURIC Acid Plants . . . Design, Construction, Equipment . . . Operation . . . Mills-Packard Water-Cooled Acid Chambers, Gaillard Acid-Cooled Chambers, Gaillard Acid Dispersers, Contact Process Sulphuric Acid Plants.

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DRYERS—Direct Heat
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Sackett & Sons Co., The A. J., Baltimore, Md.

DRIVES—Electric
Link-Belt Company, Philadelphia, Chicago.

DUMP CARS
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

DUST COLLECTING SYSTEMS
Sackett & Sons Co., The A. J., Baltimore, Md.

ELECTRIC MOTORS AND APPLIANCES
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Sackett & Sons Co., The A. J., Baltimore, Md.

ELEVATORS
Atlanta Utility Works, East Point, Ga.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

ELEVATORS AND CONVEYORS—Portable
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

ENGINEERS—Chemical and Industrial
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

ENGINES—Steam
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

EXCAVATORS AND DREDGES—Drag Line and Cableway
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Link-Belt Speeder Corp., Chicago, Ill. and Cedar Rapids, Iowa.

FERTILIZER MANUFACTURERS
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Farmers Fertilizer Co., Columbus, Ohio.
International Agricultural Corp., New York City.
Smith-Rowland Co., Norfolk, Va.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.

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Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

FOUNDERS AND MACHINISTS
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

GARBAGE TANKAGE
Wellmann, William E., Baltimore, Md.

GEARS—Machine Moulded and Cut
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

GEARS—Silent
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

GELATINE AND GLUE
American Agricultural Chemical Co., New York City.

GUANO
Baker & Bro., H. J., New York City.

HOISTS—Electric, Floor and Cage Operated, Portable
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.

HOPPERS
Atlanta Utility Works, East Point, Ga.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

IMPORTERS, EXPORTERS
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Wellmann, William E., Baltimore, Md.

IRON SULPHATE
Tennessee Corporation, Atlanta, Ga.

INSECTICIDES
American Agricultural Chemical Co., New York City.

LACING—Belt
Sackett & Sons Co., The A. J., Baltimore, Md.

LIMESTONE
American Agricultural Chemical Co., New York City.
American Limestone Co., Knoxville, Tenn.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Wellmann, William E., Baltimore, Md.

LOADERS—Car and Wagon, for Fertilizers
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Acid Making
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.
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Monarch Mfg. Works, Inc., Philadelphia, Pa.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Coal and Ash Handling
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Elevating and Conveying
Atlanta Utility Works, East Point, Ga.
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MACHINERY—Power Transmission
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Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Pumping
Atlanta Utility Works, East Point, Ga.

MACHINERY—Tankage and Fish Scrap
Atlanta Utility Works, East Point, Ga.
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MAGNESIA
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MAGNETS
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Sackett & Sons Co., The A. J., Baltimore, Md.
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MANGANESE SULPHATE AND CARBONATE
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MANGANESE SULPHATE
Tennessee Corportion, Atlanta, Ga.

MIXERS
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Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

NITRATE OF SODA
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
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Bradley & Baker, New York City.
Chilean Nitrate Sales Corp., New York City.
Huber & Company, New York City.
International Agricultural Corp., New York City.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

NITRATE OVENS AND APPARATUS
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NITROGENOUS ORGANIC MATERIAL
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Du Pont de Nemours & Co., E. I., Wilmington, Del.
Huber & Company, New York City.
International Agricultural Corp., New York City.
Smith-Rowland Co., Norfolk, Va.
Wellmann, William E., Baltimore, Md.

NOZZLES—Spray
Monarch Mfg. Works, Inc., Philadelphia, Pa.

PACKING—For Acid Towers
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

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Stedman's Foundry and Mach. Works, Aurora, Ind.

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American Cyanamid Co., New York City.
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Ashcraft-Wilkinson Co., Atlanta, Ga.
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Bradley & Baker, New York City.
Charleston Mining Co., Inc., Richmond, Va.
Huber & Company, New York City.
International Agricultural Corp., New York City.
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Ruhm, H. D., Mount Pleasant, Tenn.
Schmaltz, Jos. H., Chicago, Ill.
Southern Phosphate Corp., Baltimore, Md.
Taylor, Henry L., Wilmington, Del.
Wellmann, William E., Baltimore, Md.

PIPES—Chemical Stoneware
Chemical Construction Corp., New York City.

PIPES—Wooden
Stedman's Foundry and Mach. Works, Aurora, Ind.

PLANT CONSTRUCTION—Fertilizer and Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

POTASH SALTS—Dealers and Brokers
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
International Agricultural Corp., New York City.
Jett, Joseph C., Norfolk, Va.
Schmaltz, Jos. H., Chicago, Ill.
Synthetic Nitrogen Products Co., New York City.
Taylor, Henry L., Wilmington, Del.
Wellmann, William E., Baltimore, Md.

POTASH SALTS—Manufacturers and Importers
American Potash and Chem. Corp., New York City.
Potash Co. of America, Baltimore, Md.
United States Potash Co., New York City.

PULLEYS AND HANGERS
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

PUMPS—Acid-Resisting
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

PYRITES—Brokers
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Jett, Joseph C., Norfolk, Va.
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QUARTZ
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

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SCRAPERS—Drag
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.

SCREENS
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Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
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SEPARATORS—Air
Sackett & Sons Co., The A. J., Baltimore, Md.

SEPARATORS—Including Vibrating
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

SEPARATORS—Magnetic
Sackett & Sons Co., The A. J., Baltimore, Md.
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SHAFTING
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SHOVELS—Power
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Link-Belt Speeder Corp., Chicago, Ill. and Cedar Rapids, Iowa.
Sackett & Sons Co., The A. J., Baltimore, Md.

SPRAYS—Acid Chambers
Monarch Mfg. Works, Inc., Philadelphia, Pa.

SPROCKET WHEELS (See Chains and Sprockets)

STACKS
Sackett & Sons Co., The A. J., Baltimore, Md.

SULPHATE OF AMMONIA
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Ashcraft-Wilkinson Co., Atlanta, Ga.
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Taylor, Henry L., Wilmington, N. C.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.
Wellmann, William E., Baltimore, Md.

SUPERPHOSPHATE—Concentrated
Armour Fertilizer Works, Atlanta, Ga.
International Agricultural Corp., New York City.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.

SYPHONS—For Acid
Monarch Mfg. Works, Inc., Philadelphia, Pa.

TALLOW AND GREASE
American Agricultural Chemical Co., New York City.

TANKAGE
American Agricultural Chemical Co., New York City.
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Wellmann, William E., Baltimore, Md.

TANKAGE—Garbage
Huber & Company, New York City.

TANKS
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Sackett & Sons Co., The A. J., Baltimore, Md.

TILE—Acid-Proof
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

TOWERS—Acid and Absorption
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

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UREA
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UREA-AMMONIA LIQUOR
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VALVES—Acid-Resisting
Atlanta Utility Works, East Point, Ga.
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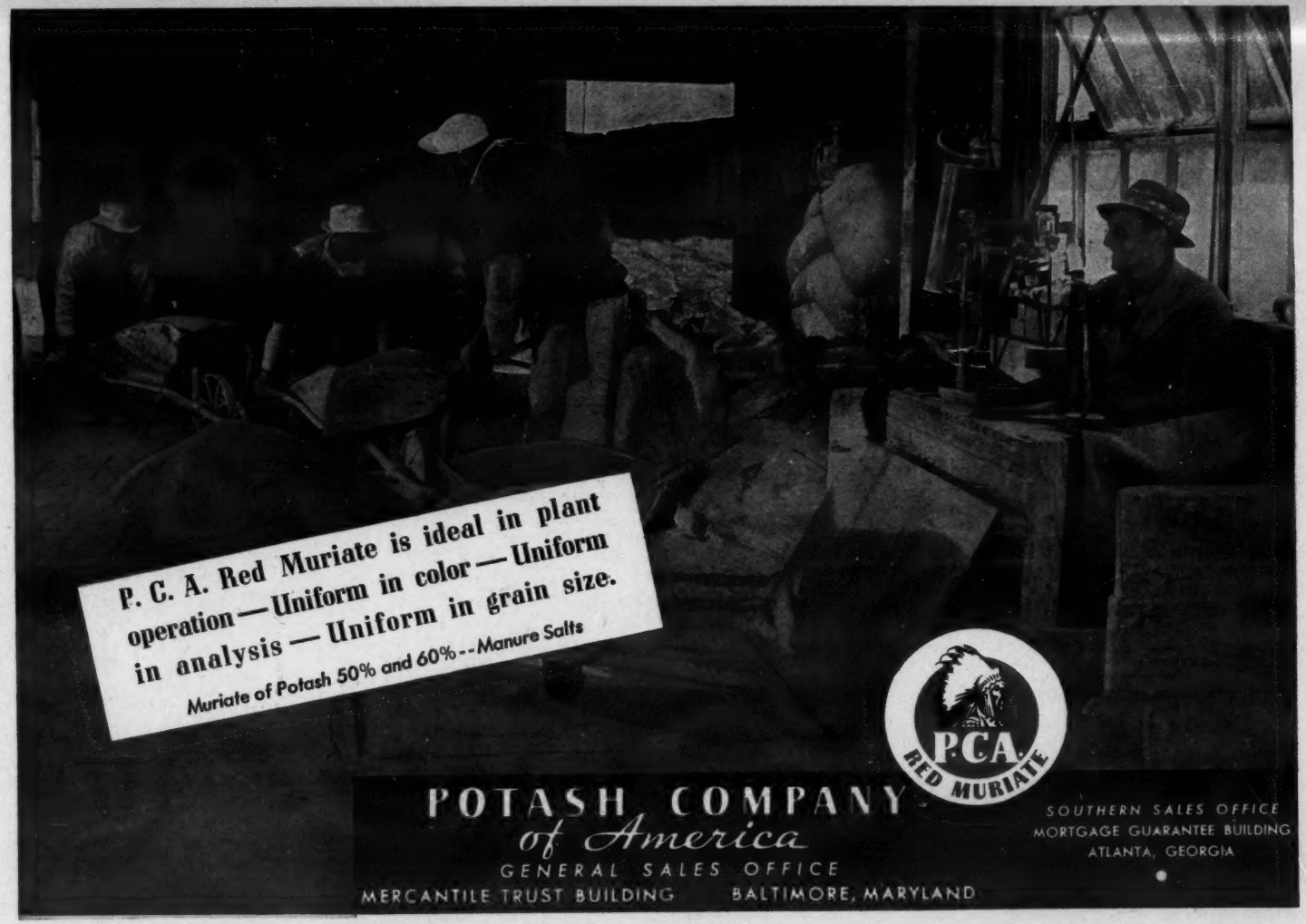
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